

REMARKS

The applicant has taken the opportunity to reformat the specification. By way of explanation, the amendments which have been made to the specification update the table of cross-referenced, simultaneously filed, patent applications. On 10 July 1998, 184 patent applications were filed simultaneously by the applicant at the USPTO covering many different inventions made as part of a complex digital imaging and printing project. The present application is one of those 184 simultaneously filed applications. Those simultaneously filed applications were initially identified in the originally filed specification by their docket numbers of the US filing and for additional identification purposes by their corresponding Australian provisional patent application numbers and filing dates. The reason for identifying the cross-referenced application in this way was simply because, at the time of filing the present application, the US filing details of the simultaneously filed applications, having been filed on the same day as the present application, were not yet known or available.

Now that the US application numbers are known and in order more clearly to identify the cross-referenced applications, the US application numbers have been added in addition to the Australian provisional application numbers.

Further, the change to the format of the charts from landscape view to portrait view was made purely to make it easier to read the specification.

A substitute specification is attached. Also, marked up copies of the amended pages of the substitute specification are attached. No new matter has been added.

With reference to the rejection of claims 1-4, Vogel discloses a camera in which the features or characteristics of the "optical sub-assembly" including lens and CCD imager are stored in a matrix coefficient memory.

The camera includes a pre-processing section which outputs RGB signals to an external digital processor, which, in turn, uses the matrix coefficients to transform the RGB signals to

adjust them for a particular output device exemplified as a CRT device or a printer. The camera and output device(s) are separate structures.

In the invention as claimed the printer and imaging system are in a handheld device. This has been made clearer by the amendments to the claims. Vogel does not contemplate such an arrangement but requires an external system of processor and output device (printer) to provide an image. The claimed invention provides an instant result printed out by the printing system. The citation and the claimed invention are not the same invention.

Moreover, the method steps of claim 1 as filed or of claim 1 as currently proposed to be amended do not disclose the steps of using a first image to adjust a second image, the second image being the one printed out.

The claimed invention allows the portable camera system to adjust to existing conditions of the environment in which the image is taken. Vogel provides a set of coefficients which are fixed at manufacture and do not change or cannot be changed even if the components of the camera are repaired or replaced. This is argued by Vogel as an asset. However, the matrix coefficients used in Vogel are determined from a given colour chart 72 and a specified illuminant 74. When an image is being taken by the camera of Vogel in practice the lighting conditions may be very different from those presented by the "specified illuminant 74" and hence the output image may be adversely affected that is, not true to the image at the time and under the conditions it was taken. This problem is avoided or ameliorated by the claimed invention.

In the claimed invention a more adaptable system is provided. The rejection under 102 (e) of claims 1, 3 and 4 is improper. There is no reference in the cited passage of col. 7, line 60- col. 8 line 5 to the "digital camera system" of Vogel utilizing "the image sensor device to sense a second image in rapid succession to a first image" The Applicant respectfully submits that the passage from col. 7, line 24 to col. 8 line 5 refers to the calibration of the camera, that is, the determination of the colour correction matrix coefficients (see col. 8 lines 17-20) and is carried out in respect of "an image of the colour chart 72 under the specified illuminant 74". No reference to obtaining two images in rapid succession or to

using the second image to provide the output is made in the passage referenced by the Examiner nor in the specification as a whole.

The Applicant respectfully submits that the rejection of claim 1 under Sec 102 has been traversed. Hence, the rejection of claim 2 under Sec 103 (a) over Vogel is moot. If the Examiner maintains the rejection of claim 2 under Sec 103 (a) over Vogel then the Applicant respectfully requests evidence to support the Examiner's assertion that "it was known in the art of digital image sensing[or] to sense the next image within one second from the previously sensed image." In a digital camera such as Vogel it is respectfully submitted that a user thereof would not take successive images every second, or would not take a pair of images within a second of one another at every exposure or image capture but would take images with periods between images which would be highly variable from several seconds, to minutes or days..

In view of the foregoing it is respectfully contended that all claims now pending in the above identified Patent Application recite a novel and not obvious method in a system which is patentably distinguishable over the prior art. Accordingly, withdrawal of the outstanding rejections and the allowance of all claims now pending are respectfully requested and earnestly solicited.

Very respectfully,

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Marked



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TITLE OF INVENTION

"A METHOD OF COLOR CORRECTION IN A DIGITAL CAMERA SYSTEM"

CROSS REFERENCES TO RELATED APPLICATIONS

The following Australian provisional patent applications are hereby incorporated by cross-reference. For the purposes of location and identification, US patent applications identified by their US patent application serial numbers (USSN) are listed alongside the Australian applications from which the US patent applications claim the right of priority.

CROSS-REFERENCED AUSTRALIAN PROVISIONAL PATENT APPLICATION No.	US PATENT/PATENT APPLICATION (CLAIMING RIGHT OF PRIORITY FROM AUSTRALIAN PROVISIONAL APPLICATION)	DOCKET No.
		RECEIVED JUL 30 2002 Technology Center 2600
PO7991	09/113,060	ART01
PO8505	09/113,070	ART02
PO7988	09/113,073	ART03
PO9395	6,322,181	ART04
PO8017	09/112,747	ART06
PO8014	09/112,776	ART07
PO8025	09/112,750	ART08
PO8032	09/112,746	ART09
PO7999	09/112,743	ART10
PO7998	09/112,742	ART11
PO8031	09/112,741	ART12
PO8030	6,196,541	ART13
PO7997	6,195,150	ART15
PO7979	09/113,053	ART16
PO8015	09/112,738	ART17
PO7978	09/113,067	ART18
PO7982	09/113,063	ART19
PO7989	09/113,069	ART20
PO8019	09/112,744	ART21
PO7980	6,356,715	ART22
PO8018	09/112,777	ART24
PO7938	09/113,224	ART25
PO8016	6,366,693	ART26
PO8024	09/112,805	ART27
PO7940	09/113,072	ART28
PO7939	09/112,785	ART29
PO8501	6,137,500	ART30
PO8500	09/112,796	ART31
PO7987	09/113,071	ART32
PO8022	09/112,824	ART33
PO8497	09/113,090	ART34
PO8020	09/112,823	ART38

CROSS-REFERENCED AUSTRALIAN PROVISIONAL PATENT APPLICATION No.	US PATENT/PATENT APPLICATION (CLAIMING RIGHT OF PRIORITY FROM AUSTRALIAN PROVISIONAL APPLICATION)	DOCKET No.
PO8023	09/113,222	ART39
PO8504	09/112,786	ART42
PO8000	09/113,051	ART43
PO7977	09/112,782	ART44
PO7934	09/113,056	ART45
PO7990	09/113,059	ART46
PO8499	09/113,091	ART47
PO8502	09/112,753	ART48
PO7981	6,317,192	ART50
PO7986	09/113,057	ART51
PO7983	09/113,054	ART52
PO8026	09/112,752	ART53
PO8027	09/112,759	ART54
PO8028	09/112,757	ART56
PO9394	09/112,758	ART57
PO9396	09/113,107	ART58
PO9397	6,271,931	ART59
PO9398	6,353,772	ART60
PO9399	6,106,147	ART61
PO9400	09/112,790	ART62
PO9401	6,304,291	ART63
PO9402	09/112,788	ART64
PO9403	6,305,770	ART65
PO9405	6,289,262	ART66
PP0959	6,315,200	ART68
PP1397	6,217,165	ART69
PP2370	09/112,781	DOT01
PP2371	09/113,052	DOT02
PO8003	09/112,834	Fluid01
PO8005	09/113,103	Fluid02
PO9404	09/113,101	Fluid03
PO8066	6,227,652	IJ01
PO8072	6,213,588	IJ02
PO8040	6,213,589	IJ03
PO8071	6,231,163	IJ04
PO8047	6,247,795	IJ05
PO8035	09/113,099	IJ06
PO8044	6,244,691	IJ07
PO8063	6,257,704	IJ08
PO8057	09/112,778	IJ09
PO8056	6,220,694	IJ10
PO8069	6,257,705	IJ11
PO8049	6,247,794	IJ12
PO8036	6,234,610	IJ13

CROSS-REFERENCED AUSTRALIAN PROVISIONAL PATENT APPLICATION NO.	US PATENT/PATENT APPLICATION (CLAIMING RIGHT OF PRIORITY FROM AUSTRALIAN PROVISIONAL APPLICATION)	DOCKET NO.
PO8048	6,247,793	IJ14
PO8070	6,264,306	IJ15
PO8067	6,241,342	IJ16
PO8001	6,247,792	IJ17
PO8038	6,264,307	IJ18
PO8033	6,254,220	IJ19
PO8002	6,234,611	IJ20
PO8068	09/112,808	IJ21
PO8062	6,283,582	IJ22
PO8034	6,239,821	IJ23
PO8039	09/113,083	IJ24
PO8041	6,247,796	IJ25
PO8004	09/113,122	IJ26
PO8037	09/112,793	IJ27
PO8043	09/112,794	IJ28
PO8042	09/113,128	IJ29
PO8064	09/113,127	IJ30
PO9389	6,227,653	IJ31
PO9391	6,234,609	IJ32
PP0888	6,238,040	IJ33
PP0891	6,188,415	IJ34
PP0890	6,227,654	IJ35
PP0873	6,209,989	IJ36
PP0993	6,247,791	IJ37
PP0890	09/112,764	IJ38
PP1398	6,217,153	IJ39
PP2592	09/112,767	IJ40
PP2593	6,243,113	IJ41
PP3991	6,283,581	IJ42
PP3987	6,247,790	IJ43
PP3985	6,260,953	IJ44
PP3983	6,267,469	IJ45
PO7935	6,224,780	IJM01
PO7936	6,235,212	IJM02
PO7937	6,280,643	IJM03
PO8061	6,284,147	IJM04
PO8054	6,214,244	IJM05
PO8065	6,071,750	IJM06
PO8055	6,267,905	IJM07
PO8053	6,251,298	IJM08
PO8078	6,258,285	IJM09
PO7933	6,225,138	IJM10
PO7950	6,241,904	IJM11
PO7949	09/113,129	IJM12

CROSS-REFERENCED AUSTRALIAN PROVISIONAL PATENT APPLICATION No.	US PATENT/PATENT APPLICATION (CLAIMING RIGHT OF PRIORITY FROM AUSTRALIAN PROVISIONAL APPLICATION)	DOCKET No.
PO8060	09/113,124	IJM13
PO8059	6,231,773	IJM14
PO8073	6,190,931	IJM15
PO8076	6,248,249	IJM16
PO8075	09/113,120	IJM17
PO8079	6,241,906	IJM18
PO8050	09/113,116	IJM19
PO8052	6,241,905	IJM20
PO7948	09/113,117	IJM21
PO7951	6,231,772	IJM22
PO8074	6,274,056	IJM23
PO7941	09/113,110	IJM24
PO8077	6,248,248	IJM25
PO8058	09/113,087	IJM26
PO8051	09/113,074	IJM27
PO8045	6,110,754	IJM28
PO7952	09/113,088	IJM29
PO8046	09/112,771	IJM30
PO9390	6,264,849	IJM31
PO9392	6,254,793	IJM32
PP0889	6,235,211	IJM35
PP0887	09/112,801	IJM36
PP0882	6,264,850	IJM37
PP0874	6,258,284	IJM38
PP1396	09/113,098	IJM39
PP3989	6,228,668	IJM40
PP2591	6,180,427	IJM41
PP3990	6,171,875	IJM42
PP3986	6,267,904	IJM43
PP3984	6,245,247	IJM44
PP3982	09/112,835	IJM45
PP0895	6,231,148	IR01
PP0870	09/113,106	IR02
PP0869	09/113,105	IR04
PP0887	09/113,104	IR05
PP0885	6,238,033	IR06
PP0884	09/112,766	IR10
PP0886	6,238,111	IR12
PP0871	09/113,086	IR13
PP0876	09/113,094	IR14
PP0877	09/112,760	IR16
PP0878	6,196,739	IR17
PP0879	09/112,774	IR18
PP0883	6,270,182	IR19

CROSS-REFERENCED AUSTRALIAN PROVISIONAL PATENT APPLICATION No.	US PATENT/PATENT APPLICATION (CLAIMING RIGHT OF PRIORITY FROM AUSTRALIAN PROVISIONAL APPLICATION)	DOCKET No.
PP0880	6,152,619	IR20
PP0881	09/113,092	IR21
PO8006	6,087,638	MEMS02
PO8007	09/113,093	MEMS03
PO8008	09/113,062	MEMS04
PO8010	6,041,600	MEMS05
PO8011	09/113,082	MEMS06
PO7947	6,067,797	MEMS07
PO7944	09/113,080	MEMS09
PO7946	6,044,646	MEMS10
PO9393	09/113,065	MEMS11
PP0875	09/113,078	MEMS12
PP0894	09/113,075	MEMS13

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

5 FIELD OF THE INVENTION

The present invention relates substantially to the concept of a disposable camera having instant printing capabilities and in particular, discloses [A Method of Color Correction in a Digital Camera System] a method of color correction in a digital camera.

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BACKGROUND OF THE INVENTION

Recently, the concept of a "single use" disposable camera has become an increasingly popular consumer item. Disposable camera systems presently on the market normally include an internal film roll and a simplified gearing mechanism for traversing the film roll across an imaging system including a shutter and lensing system. The user, after utilising a single film roll returns the camera system to a film development centre for processing. The film roll is taken out of the camera system and processed and the prints returned to the user. The camera system is then able to be re-manufactured through the insertion of a new film roll into the camera system, the replacement of any worn or wearable parts and the re-packaging of the camera system in accordance with requirements. In this way, the concept of a single use "disposable" camera is provided to the consumer.

Recently, a camera system has been proposed by the present applicant which provides for a handheld camera device having an internal [print head] printhead, image sensor and processing means such that images sense by the

image sensing means, are processed by the processing means and adapted to be instantly printed out by the printing means on demand. The proposed camera system further discloses a system of internal "print rolls" carrying print media such as film on to which images are to be printed in addition to ink [to] for supplying to the printing means for the printing process. The print roll is further disclosed to be detachable and replaceable within the camera system.

Unfortunately, such a system is likely to only be constructed at a substantial cost and it would be desirable to provide for a more inexpensive form of instant camera system which maintains a substantial number of the quality aspects of the aforementioned arrangement.

It would be advantageous to provide for a camera system having an effective color correction or [gamut] gamma remapping capabilit[ies.]y.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide for [the] an efficient and effective color correction capabilities for a camera system.

In accordance with a first aspect of the present invention, there is provided in a camera system including: an image sensor device for sensing an image; a processing means for processing the sensed image; and a printing system for printing out the sensed image; a method of color correcting a sensed image to be printed out by the [print head] printhead, comprising: utilizing the image sensor device to sense a first image; processing the first image to determine color characteristics of a first sensed image; utilizing the image sensor device to sense a second image, in rapid succession to the first image; applying color correction methods to the second image based on the determined color characteristics of the first sensed image; and printing out the second image.

Preferably, the second sensed image is sensed within 1 second of the first sensed image and the processing step includes examining the intensity characteristics of the first image. The processing step can include determining a maximum and minimum intensity of the first image and utilizing the intensities to rescale the intensities of the second image.

BRIEF DESCRIPTION OF THE DRAWINGS

Notwithstanding any other forms which may fall within the scope of the present invention, preferred forms of the invention will now be described, by way of example only, with reference to the accompanying
5 drawings in which:

Fig. 1 [illustrated] illustrates a [side] front perspective view of the assembled camera of the preferred embodiment;

Fig. 2 illustrates a [back side] rear perspective view, partly exploded, of the preferred embodiment;

10 Fig. 3 is a [side] perspective view of the chassis of the preferred embodiment;

Fig. 4 is a [side] perspective view of the chassis illustrating [the insertion] mounting of [the] electric motors;

15 Fig. 5 is an exploded perspective view of the ink supply mechanism of the preferred embodiment;

Fig. 6 is [a side] rear perspective of the assembled form of the ink supply mechanism of the preferred embodiment;

Fig. 7 is a front perspective view of the assembled form of the ink supply mechanism of the preferred embodiment;

20 Fig. 8 is an exploded perspective view of the platten unit of the preferred embodiment;

Fig. 9 is a [side] perspective view of the assembled form of the platten unit;

25 Fig. 10 is also a perspective view of the assembled form of the platten unit;

Fig. 11 is an exploded perspective [unit] view of the printhead recapping mechanism of the preferred embodiment;

Fig. 12 is a close up exploded perspective view of the recapping mechanism of the preferred embodiment;

30 Fig. 13 is an exploded perspective view of the ink supply cartridge of the preferred embodiment;

Fig. 14 is a close up perspective view, partly in section of the internal portions of the ink supply cartridge in an assembled form;

35 Fig. 15 is a schematic block diagram of one form of chip layer of the image capture and processing chip of the preferred embodiment;

Fig. 16 is an exploded perspective view illustrating the assembly process of the preferred embodiment;

Fig. 17 illustrates a front exploded perspective view of the assembly process of the preferred embodiment;

40 Fig. 18 illustrates a [side] perspective view of the assembly process of the preferred embodiment;

Fig. 19 illustrates a [side] perspective view of the assembly process of the preferred embodiment;

Fig. 20 is a perspective view illustrating the insertion of the platten unit in the preferred embodiment;

5 Fig. 21 illustrates the interconnection of the electrical components of the preferred embodiment;

Fig. 22 illustrates the process of assembling the preferred embodiment; and

10 Fig. 23 is a perspective view further illustrating the assembly process of the preferred embodiment.

DESCRIPTION OF PREFERRED AND OTHER EMBODIMENTS

Turning [initially simultaneously] to Fig. 1[,] and Fig. 2 there [is] an illustrated perspective views of an assembled camera constructed in accordance with the preferred embodiment with Fig. 1 showing a front [side] perspective view and Fig. 2 showing a [back side] rear perspective view. The camera 1 includes a paper or plastic film jacket 2 which can include simplified instructions 3 for the operation of the camera system 1. The camera system 1 includes a first "take" button 4 which is depressed to capture an image. The captured image is output via output slot 6. A further copy of the image can be obtained through depressing a second "printer copy" button 7 whilst an LED light 5 is illuminated. The camera system also provides the usual view finder 8 in addition to a CCD image capture/lensing system 9.

25 The camera system 1 provides for a standard number of output prints after which the camera system 1 ceases to function. A prints left indicator slot 10 is provided to indicate the number of remaining prints. A refund scheme at the point of purchase is assumed to be operational for the return of used camera systems for recycling.

30 Turning now to Fig. 3, the assembly of the camera system is based around an internal chassis 12 which can be a plastic injection molded part. A pair of paper pinch rollers 28, 29 utilized for decurling are snap fitted into corresponding frame holes eg. 26, 27.

As shown in Fig. 4, the chassis 12 includes a series of mutually opposed prongs eg. 13, 14 into which is snap[ped] fitted a series of electric motors 16, 17. The electric motors 16, 17 can be entirely standard with the motor 16 being of a stepper motor type. The motors 16, 17 and include [a cogged end portion] cogs 19, 20 for driving a series of gear [wells] wheels. A first set of gear [wells] wheels is provided for controlling a paper cutter mechanism and a second set is provided for

controlling print roll movement.

Turning next to Figs. 5 to 7, there is illustrated an ink supply mechanism 40 utilized in the camera system. Fig. 5 illustrates a [back] rear exploded perspective view, Fig. 6 illustrates a [back] assembled perspective view and Fig. 7 illustrates a front assembled view. The ink supply mechanism 40 is based around an ink supply cartridge 42 which contains printer ink and a [print head] printhead mechanism for printing out pictures on demand. The ink supply cartridge 42 includes a side aluminium strip 43 which is provided as a shear strip to assist in cutting images from a paper roll.

A dial mechanism 44 is provided for indicating the number of "prints left". The dial mechanism 44 is snap fitted through a corresponding mating portion 46 so as to be freely rotatable.

As shown in Fig. 6, the [print head] mechanism 40 includes a flexible PCB strip 47 which interconnects with the [print head] printhead and provides for control of the [print head] printhead. The interconnection between the Flex PCB strip and an image sensor and [print head] printhead chip can be via Tape Automated Bonding (TAB) [S]strips 51, 58. A moulded aspherical lens and aperture shim 50 (Fig. 5) is also provided for imaging an image onto the surface of the image sensor chip normally located within cavity 53 and a light box module or hood 52 is provided for snap fitting over the cavity 53 so as to provide for proper light control. A series of decoupling capacitors eg. 34 can also be provided. Further a plug 45 (Fig. 7) is provided for re-plugging ink holes after refilling. A series of guide prongs eg. 55-57 are further provided for guiding the flexible PCB strip 47.

The ink supply mechanism 40 interacts with a platten unit 60 which guides print media under a printhead located [int eh] in the ink supply mechanism. Fig. 8 shows an exploded view of the platten unit 60, while Figs. 9 and 10 show assembled views of the platten unit. The platten unit 60 includes a first pinch roller 61 which is snap fitted to one side of a platten base 62. Attached to a second side of the platten base 62 is a cutting mechanism 63 which traverses the platten unit 60 by means of a rod 64 having a screw[ed] thread which is rotated by means of cogged wheel 65 which is also fitted to the platten base 62. The screw[ed] threaded [engages] rod 64 mounts a block 67 which includes a cutting wheel 68 fastened via a fastener 69. Also mounted to the block 67 is a counter actuator which includes a [prong] pawl 71. The [prong] pawl 71 acts to rotate the dial mechanism 44 of Fig. 6 upon the return traversal of the cutting wheel. As shown previously in Fig. 6, the dial mechanism 44

includes a cogged surface which interacts with pawl [lever 73] 71, thereby maintaining a count of the number of photographs [taken] by means of numbers embossed on the surface of dial mechanism 44. The cutting mechanism 63 is inserted into the platten base 62 by means of a snap fit
 5 via [receptacle eg.] clips 74.

The platten [62] unit 60 includes an internal recapping mechanism 80 for recapping the [print head] printhead when not in use. The recapping mechanism 80 includes a sponge portion 81 and is operated via a solenoid coil so as to provide for recapping of the [print head] printhead. In the
 10 preferred embodiment, there is provided an inexpensive form of printhead re-capping mechanism provided for incorporation into a handheld camera system so as to provide for printhead re-capping of an inkjet printhead.

Fig. 11 illustrates an exploded view of the recapping mechanism whilst Fig. 12 illustrates a close up of the end portion thereof. The re-capping mechanism [90] 80 is structured around a solenoid including a 16
 15 turn coil 75 which can comprise insulated wire. The coil 75 is turned around a first stationery solenoid arm 76 which is mounted on a bottom surface of the [pattern] platten base 62 (Fig. 8) and includes a post portion 77 to magnify effectiveness of operation. The arm 76 can comprise
 20 a ferrous material.

A second moveable arm 78 of the solenoid actuator is also provided [78]. The arm 78 [being] is moveable and also is made of ferrous material. Mounted on the arm is a sponge portion surrounded by an elastomer strip 79. The elastomer strip 79 is of a generally arcuate cross-section and acts
 25 as a leaf spring[s] against the surface of the printhead ink supply cartridge 42 (Fig. 5) so as to provide for a seal against the surface of the printhead ink supply cartridge 42. In the quiescent position [a] elastomer spring units 87, 88 act to resiliently deform the elastomer seal 79 against the surface of the ink supply unit 42.

When it is desired to operate the printhead unit, upon the insertion
 30 of paper, the solenoid coil 75 is activated so as to cause the arm 78 to move down to be adjacent to the end plate 76. The arm 78 is held against end plate 76 while the printhead is printing by means of a small "keeper current" in coil [77] 75. Simulation results indicate that the keeper
 35 current can be significantly less than the actuation current. Subsequently, after photo printing, the paper is guillotined by the cutting mechanism 63 of Fig. 8 acting against Aluminium Strip 43 [of Fig. 5], and rewound so as to clear the area of the re-capping mechanism [88] 80. Subsequently, the current is turned off and springs 87, 88 return the arm
 40 78 so that the elastomer seal is again resting against the printhead ink

supply cartridge.

It can be seen that the preferred embodiment provides for a simple and inexpensive means of re-capping a printhead through the utilisation of a solenoid type device having a long rectangular form. Further, the preferred embodiment utilises minimal power in that currents are only required whilst the device is operational and additionally, only a low keeper current is required whilst the printhead is printing.

Turning next to Fig. 13 and 14, Fig. 13 illustrates an exploded perspective of the ink supply cartridge 42 whilst Fig. 14 illustrates a close up sectional view of a bottom of the ink supply cartridge with the printhead unit in place. The ink supply cartridge 42 is based around a pagewidth printhead 102 which comprises a long slither of silicon having a series of holes etched on the back surface for the supply of ink to a front surface of the silicon wafer for subsequent ejection via a micro electro mechanical system. The form of ejection can be many different forms such as those set out in the tables below.

Of course, many other inkjet technologies, as referred to the attached tables below, can also be utilised when constructing a printhead unit 102. The fundamental requirement of the ink supply cartridge 42 [being] is the supply of ink to a series of colour channels etched through the back surface of the printhead 102. In the description of the preferred embodiment, it is assumed that a three colour printing process is to be utilised so as to provide full colour picture output. Hence, the print supply unit [42] includes three ink supply reservoirs being a cyan reservoir 104, a magenta reservoir 105 and a yellow reservoir 106. Each of these reservoirs is required to store ink and includes a corresponding sponge type material 107 - 109 which assists in stabilising ink within the corresponding ink channel and [therefore preventing] inhibiting the ink from sloshing back and forth when the printhead is utilised in a handheld camera system. The reservoirs 104, 105, 106 are formed through the mating of first exterior plastic piece 110 [mating with] and a second base piece[] 111.

At a first end 118 of the base piece [11 includes] 111 a series of air inlets 113 - 115 are provided. [The] Each air inlet leads to a corresponding winding channel which is hydrophobically treated so as to act as an ink repellent and therefore repel any ink that may flow along the air inlet channel. The air inlet channel further takes a convoluted path further assisting in resisting any ink flow out of the chambers 104 - 106. An adhesive tape portion 117 is provided for sealing the channels within end portion 118.

At the top end, there is included a series of refill holes (not shown) for refilling corresponding ink supply chambers 104, 105, 106. A plug 121 is provided for sealing the refill holes.

Turning now to Fig. 14, there is illustrated a close up perspective view, partly in section through the ink supply cartridge 42 of Fig. 13 when formed as a unit. The ink supply cartridge includes the three colour ink reservoirs 104, 105, 106 which supply ink to different portions of the back surface of printhead 102 which includes a series of apertures 128 defined therein for carriage of the ink to the front surface.

The ink supply [unit] cartridge 42 includes two guide walls 124, 125 which separate the various ink chambers and are tapered into an end portion abutting the surface of the printhead 102. The guide walls 124, 125 are further mechanically supported [and regular spaces] by [a] block portions eg. 126 which are placed at regular intervals along the length of the [printhead] ink supply unit. The block portions 126 [leaving] leave space at portions close to the back of printhead 102 for the flow of ink around the back surface thereof.

The [printhead] ink supply unit is preferably formed from a multi-part plastic injection mo[u]ld and the mo[u]ld pieces eg. [10, 11] 110, 111 (Fig. [1] 13) snap together around the sponge pieces 107, 109. Subsequently, a syringe type device can be inserted in the ink refill holes and the ink reservoirs filled with ink with the air flowing out of the air outlets 113 - 115. Subsequently, the adhesive tape portion 117 and plug 121 are attached and the printhead tested for operation capabilities. Subsequently, the ink supply cartridge 42 can be readily removed for refilling by means of removing the ink supply cartridge, performing a washing cycle, and then utilising the holes for the insertion of a refill syringe filled with ink for refilling the ink chamber before returning the ink supply cartridge 42 to a camera.

Turning now to Fig. 15, there is shown an example layout of the Image Capture and Processing Chip (ICP) 48.

The Image Capture and Processing Chip 48 provides most of the electronic functionality of the camera with the exception of the [print head] printhead chip. The chip 48 is a highly integrated system. It combines CMOS image sensing, analog to digital conversion, digital image processing, DRAM storage, ROM, and miscellaneous control functions in a single chip.

The chip is estimated to be around 32 mm² using a leading edge 0.18 micron CMOS/DRAM/APS process. The chip size and cost can scale somewhat with Moore's law, but is dominated by a CMOS active pixel

sensor array 201, so scaling is limited as the sensor pixels approach the diffraction limit.

The ICP 48 includes CMOS logic, a CMOS image sensor, DRAM, and analog circuitry. A very small amount of flash memory or other non-volatile memory
5 is also preferably included for protection against reverse engineering.

Alternatively, the ICP can readily be divided into two chips: one for the CMOS imaging array, and the other for the remaining circuitry. The cost of this two chip solution should not be significantly different than the single chip ICP, as the extra cost of packaging and bond-pad area is
10 somewhat cancelled by the reduced total wafer area requiring the color filter fabrication steps.

The ICP preferably contains the following functions:

Function
1.5 megapixel image sensor
Analog Signal Processors
Image sensor column decoders
Image sensor row decoders
Analogue to Digital Conversion (ADC)
Column ADC's
Auto exposure
12 Mbits of DRAM
DRAM Address Generator
Color interpolator
Convolver
Color ALU
Halftone matrix ROM
Digital halftoning
[print head] printhead interface
8 bit CPU core
Program ROM
Flash memory
Scratchpad SRAM
Parallel interface (8 bit)
Motor drive transistors (5)
Clock PLL
JTAG test interface
Test circuits
Busses
Bond pads

15 The CPU, DRAM, Image sensor, ROM, Flash memory, Parallel interface, JTAG interface and ADC can be vendor supplied cores. The ICP is intended to run on 1.5V to minimize power consumption and allow convenient operation from two AA type battery cells.

Fig. 15 illustrates a layout of the ICP 48. The ICP 48 is dominated
20 by the imaging array 201, which consumes around 80% of the chip area. The

imaging array is a CMOS 4 transistor active pixel design with a resolution of 1,500 x 1,000. The array can be divided into the conventional configuration, with two green pixels, one red pixel, and one blue pixel in each pixel group. There are 750 x 500 pixel groups in the imaging array.

5 The latest advances in the field of image sensing and CMOS image sensing in particular can be found in the October, 1997 issue of IEEE Transactions on Electron Devices and, in particular, pages 1689 to 1968. Further, a specific implementation similar to that disclosed in the present application is disclosed in Wong et. al, "CMOS Active Pixel Image Sensors
10 Fabricated Using a 1.8V, 0.25 μm CMOS Technology", IEDM 1996, page 915

The imaging array uses a 4 transistor active pixel design of a standard configuration. To minimize chip area and therefore cost, the image sensor pixels should be as small as feasible with the technology available. With a four transistor cell, the typical pixel size scales as 20 times the
15 lithographic feature size. This allows a minimum pixel area of around 3.6 μm x 3.6 μm . However, the photosite must be substantially above the diffraction limit of the lens. It is also advantageous to have a square photosite, to maximize the margin over the diffraction limit in both horizontal and vertical directions. In this case, the photosite can be
20 specified as 2.5 μm x 2.5 μm . The photosite can be a photogate, pinned photodiode, charge modulation device, or other sensor.

The four transistors are packed as an 'L' shape, rather than a rectangular region, to allow both the pixel and the photosite to be square. This reduces the transistor packing density slightly, increasing pixel
25 size. However, the advantage in avoiding the diffraction limit is greater than the small decrease in packing density.

The transistors also have a gate length which is longer than the minimum for the process technology. These have been increased from a drawn length of 0.18 micron to a drawn length of 0.36 micron. This is to improve
30 the transistor matching by making the variations in gate length represent a smaller proportion of the total gate length.

The extra gate length, and the 'L' shaped packing, mean that the transistors use more area than the minimum for the technology. Normally, around 8 μm^2 would be required for rectangular packing. Preferably, 9.75
35 μm^2 has been allowed for the transistors.

The total area for each pixel is 16 μm^2 , resulting from a pixel size of 4 μm x 4 μm . With a resolution of 1,500 x 1,000, the area of the imaging array 101 is 6,000 μm x 4,000 μm , or 24 mm^2 .

The presence of a color image sensor on the chip affects the process

required in two major ways:

-The CMOS fabrication process should be optimized to minimize dark current

Color filters are required. These can be fabricated using dyed
5 photosensitive polyimides, resulting in an added process complexity of three spin coatings, three photolithographic steps, three development steps, and three hardbakes.

There are 15,000 analog signal processors (ASPs) 205, one for each of the columns of the sensor. The ASPs amplify the signal, provide a dark
10 current reference, sample and hold the signal, and suppress the fixed pattern noise (FPN).

There are 375 analog to digital converters 206, one for each four columns of the sensor array. These may be delta-sigma or successive approximation type ADC's. A row of low column ADC's are used to reduce
15 the conversion speed required, and the amount of analog signal degradation incurred before the signal is converted to digital. This also eliminates the hot spot (affecting local dark current) and the substrate coupled noise that would occur if a single high speed ADC was used. Each ADC also has two four bit DAC's which trim the offset and scale of the ADC to further
20 reduce FPN variations between columns. These DAC's are controlled by data stored in flash memory during chip testing.

The column select logic 204 is a 1:1500 decoder which enables the appropriate digital output of the ADCs onto the output bus. As each ADC is shared by four columns, the least significant two bits of the row select
25 control 4 input analog multiplex[o]uers.

A row decoder 207 is a 1:1000 decoder which enables the appropriate row of the active pixel sensor array. This selects which of the 1000 rows of the imaging array is connected to analog signal processors. As the rows are always accessed in sequence, the row select logic can be implemented as
30 a shift register.

An auto exposure system 208 adjusts the reference voltage of the ADC 205 in response to the maximum intensity sensed during the previous frame period. Data from the green pixels is passed through a digital peak detector. The peak value of the image frame period before capture (the
35 reference frame) is provided to a digital to analogue converter(DAC), which generates the global reference voltage for the column ADCs. The peak detector is reset at the beginning of the reference frame. The minimum and maximum values of the three RGB color components are also collected for color correction.

40 The second largest section of the chip is consumed by a DRAM 210 used

to hold the image. To store the 1,500 x 1,000 image from the sensor without compression, 1.5 Mbytes of DRAM 210 are required. This equals 12 Mbits, or slightly less than 5% of a 256 Mbit DRAM. The DRAM technology assumed is of the 256 Mbit generation implemented using 0.18 μ m CMOS.

5 Using a standard 8F cell, the area taken by the memory array is 3.11 mm². When row decoders, column sensors, redundancy, and other factors are taken into account, the DRAM requires around 4 mm².

10 This DRAM 210 can be mostly eliminated if analog storage of the image signal can be accurately maintained in the CMOS imaging array for the two seconds required to print the photo. However, digital storage of the image is preferable as it is maintained without degradation, is insensitive to noise, and allows copies of the photo to be printed considerably later.

15 A DRAM address generator 211 provides the write and read addresses to the DRAM 210. Under normal operation, the write address is determined by the order of the data read from the CMOS image sensor 201. This will typically be a simple raster format. However, the data can be read from the sensor 201 in any order, if matching write addresses to the DRAM are generated. The read order from the DRAM 210 will normally simply match the requirements of a color interpolator and the [print head] printhead. As the
20 cyan, magenta, and yellow rows of the [print head] printhead are necessarily offset by a few pixels to allow space for nozzle actuators, the colors are not read from the DRAM simultaneously. However, there is plenty of time to read all of the data from the DRAM many times during the printing process. This capability is used to eliminate the need for FIFOs
25 in the [print head] printhead interface, thereby saving chip area. All three RGB image components can be read from the DRAM each time color data is required. This allows a color space converter to provide a more sophisticated conversion than a simple linear RGB to CMY conversion.

30 Also, to allow two dimensional filtering of the image data without requiring line buffers, data is re-read from the DRAM array.

35 The address generator may also implement image effects in certain models of camera. For example, passport photos are generated by a manipulation of the read addresses to the DRAM. Also, image framing effects (where the central image is reduced), image warps, and kaleidoscopic effects can all be generated by manipulating the read addresses of the DRAM.

40 While the address generator 211 may be implemented with substantial complexity if effects are built into the standard chip, the chip area required for the address generator is small, as it consists only of address counters and a moderate amount of random logic.

A color interpolator 214 converts the interleaved pattern of red, 2 x green, and blue pixels into RGB pixels. It consists of three 8 bit adders and associated registers. The divisions are by either 2 (for green) or 4 (for red and blue) so they can be implemented as fixed shifts in the output connections of the adders.

A convolver 215 is provided as a sharpening filter which applies a small convolution kernel (5 x 5) to the red, green, and blue planes of the image. The convolution kernel for the green plane is different from that of the red and blue planes, as green has twice as many samples. The sharpening filter has five functions:

- To improve the color interpolation from the linear interpolation provided by the color interpolator, to a close approximation of a [sinc] sync interpolation.

- To compensate for the image 'softening' which occurs during digitization.

- To adjust the image sharpness to match average consumer preferences, which are typically for the image to be slightly sharper than reality. As the single use camera is intended as a consumer product, and not a professional photographic products, the processing can match the most popular settings, rather than the most accurate.

- To suppress the sharpening of high frequency (individual pixel) noise. The function is similar to the 'unsharp mask' process.

- To antialias Image Warping.

These functions are all combined into a single convolution matrix. As the pixel rate is low (less than 1 Mpixel per second) the total number of multiplies required for the three color channels is 56 million multiplies per second. This can be provided by a single multiplier. Fifty bytes of coefficient ROM are also required.

A color ALU 113 combines the functions of color compensation and color space conversion into the one matrix multiplication, which is applied to every pixel of the frame. As with sharpening, the color correction should match the most popular settings, rather than the most accurate.

A color compensation circuit of the color ALU provides compensation for the lighting of the photo. The vast majority of photographs are substantially improved by a simple color compensation, which independently normalizes the contrast and brightness of the three color components.

A color look-up table (CLUT) 212 is provided for each color component. These are three separate 256 x 8 SRAMs, requiring a total of 6,144 bits. The CLUTs are used as part of the color correction process. They are also used for color special effects, such as stochastically

selected "wild color" effects.

A color space conversion system of the color ALU converts from the RGB color space of the image sensor to the CMY color space of the printer. The simplest conversion is a 1's complement of the RGB data. However, this
 5 simple conversion assumes perfect linearity of both color spaces, and perfect dye spectra for both the color filters of the image sensor, and the ink dyes. At the other extreme is a tri-linear interpolation of a sampled three dimensional arbitrary transform table. This can effectively match any non-linearity or differences in either color space. Such a system is
 10 usually necessary to obtain good color space conversion when the print engine is a color electrophotographic.

However, since the non-linearity of a halftoned ink jet output is very small, a simpler system can be used. A simple matrix multiply can provide excellent results. This requires nine multiplies and six additions
 15 per contone pixel. However, since the contone pixel rate is low (less than 1 Mpixel/sec) these operations can share a single multiplier and adder. The multiplier and adder are used in a color ALU which is shared with the color compensation function.

Digital halftoning can be performed as a dispersed dot ordered dither using a stochastic optimized dither cell. A halftone matrix ROM [116] 216
 20 is provided for storing dither cell coefficients. A dither cell size of 32 x 32 is adequate to ensure that the cell repeat cycle is not visible. The three colors - cyan, magenta, and yellow - are all dithered using the same cell, to ensure maximum co-positioning of the ink dots. This minimizes
 25 'muddying' of the mid-tones which results from bleed of dyes from one dot to adjacent dots while still wet. The total ROM size required is 1 KByte, as the one ROM is shared by the halftoning units for each of the three colors.

The digital halftoning used is dispersed dot ordered dither with stochastic optimized dither matrix. While dithering does not produce an
 30 image quite as 'sharp' as error diffusion, it does produce a more accurate image with fewer artifacts. The image sharpening produced by error diffusion is artificial, and less controllable and accurate than 'unsharp mask' filtering performed in the contone domain. The high print resolution
 35 (1,600 dpi x 1,600 dpi) results in excellent quality when using a well formed stochastic dither matrix.

Digital halftoning is performed by a digital halftoning unit 217 using a simple comparison between the contone information from the DRAM 210
 40 and the contents of the dither matrix 216. During the halftone process, the resolution of the image is changed from the 250 dpi of the captured contone

image to the 1,600 dpi of the printed image. Each contone pixel is converted to an average of 40.96 halftone dots.

The ICP incorporates [an] a 16 bit microcontroller CPU core 219 to run the miscellaneous camera functions, such as reading the buttons, controlling the motor and solenoids, setting up the hardware, and authenticating the refill station. The processing power required by the CPU is very modest, and a wide variety of processor cores can be used. As the entire CPU program is run from a small ROM 220. [P]program compatibility between camera versions is not important, as no external programs are run. A 2 Mbit (256 Kbyte) program and data ROM 220 is included on chip. Most of this ROM space is allocated to data for outline graphics and fonts for specialty cameras. The program requirements are minor. The single most complex task is the encrypted authentication of the refill station. The ROM requires a single transistor per bit.

A Flash memory 221 may be used to store a 128 bit authentication code. This provides higher security than storage of the authentication code in ROM, as reverse engineering can be made essentially impossible. The Flash memory is completely covered by third level metal, making the data impossible to extract using scanning probe microscopes or electron beams. The authentication code is stored in the chip when manufactured. At least two other Flash bits are required for the authentication process: a bit which locks out reprogramming of the authentication code, and a bit which indicates that the camera has been refilled by an authenticated refill station. The flash memory can also be used to store FPN correction data for the imaging array. Additionally, a phase locked loop rescaling parameter is stored [is] and provided for scaling the clocking cycle to an appropriate correct time. The clock frequency does not require crystal accuracy since no date functions are provided. To eliminate the cost of a crystal, an on chip oscillator with a phase locked loop [124] 224 is used. As the frequency of an on-chip oscillator is highly variable from chip to chip, the frequency ratio of the oscillator to the PLL is digitally trimmed during initial testing. The value is stored in Flash memory [121] 221. This allows the clock PLL to control the ink-jet heater pulse width with sufficient accuracy.

A scratchpad SRAM is a small static RAM 222 with a 6T cell. The scratchpad provide[d]s temporary memory for the 16 bit CPU. 1024 bytes is adequate.

A [print head] printhead interface 223 formats the data correctly for the [print head] printhead. The [print head] printhead interface also provides all of the timing signals required by the [print head] printhead.

These timing signals may vary depending upon temperature, the number of dots printed simultaneously, the print medium in the print roll, and the dye density of the ink in the print roll.

The following is a table of external connections to the [print head] printhead interface:

Connection	Function	Pins
DataBits[0-7]	Independent serial data to the eight segments of the [print head] <u>printhead</u>	8
BitClock	Main data clock for the [print head] <u>printhead</u>	1
ColorEnable[0-2]	Independent enable signals for the CMY actuators, allowing different pulse times for each color.	3
BankEnable[0-1]	Allows either simultaneous or interleaved actuation of two banks of nozzles. This allows two different print speed/power consumption tradeoffs	2
NozzleSelect[0-4]	Selects one of 32 banks of nozzles for simultaneous actuation	5
ParallelXferClock	Loads the parallel transfer register with the data from the shift registers	1
Total		20

The [print head] printhead utilized is composed of eight identical segments, each 1.25 cm long. There is no connection between the segments on the [print head] printhead chip. Any connections required are made in the external TAB bonding film, which is double sided. The division into eight identical segments is to simplify lithography using wafer steppers. The segment width of 1.25 cm fits easily into a stepper field. As the [print head] printhead chip is long and narrow (10 cm x 0.3 mm), the stepper field contains a single segment of 32 [print head] printhead chips. The stepper field is therefore 1.25 cm x 1.6 cm. An average of four complete [print head] printheads are patterned in each wafer step.

A single BitClock output line connects to all 8 segments on the [print head] printhead. The 8 DataBits lines lead one to each segment, and are clocked in to the 8 segments on the [print head] printhead simultaneously (on a BitClock pulse). For example, dot 0 is transferred to segment₀, dot 750 is transferred to segment₁, dot 1500 to segment₂, etc

simultaneously.

The ParallelXferClock is connected to each of the 8 segments on the [print head] printhead, so that on a single pulse, all segments transfer their bits at the same time.

5 The NozzleSelect, BankEnable and ColorEnable lines are connected to each of the 8 segments, allowing the [print head] printhead interface to independently control the duration of the cyan, magenta, and yellow nozzle energizing pulses. Registers in the [print head] printhead Interface allow the accurate specification of the pulse duration between 0 and 6 ms, with a
10 typical duration of 2 ms to 3 ms.

A parallel interface 125 connects the ICP to individual static electrical signals. The CPU is able to control each of these connections as memory mapped I/O via a low speed bus.

The following is a table of connections to the parallel interface:

15

Connection	Direction	Pins
Paper transport stepper motor	Output	4
Capping solenoid	Output	1
Copy LED	Output	1
Photo button	Input	1
Copy button	Input	1
Total		8

Seven high current drive transistors eg. 227 are required. Four are for the four phases of the main stepper motor, two are for the guillotine motor, and the remaining transistor is to drive the capping solenoid. These
20 transistors are allocated 20,000 square microns (600,000 F) each. As the transistors are driving highly inductive loads, they must either be turned off slowly, or be provided with a high level of back EMF protection. If adequate back EMF protection cannot be provided using the chip process chosen, then external discrete transistors should be used. The transistors
25 are never driven at the same time as the image sensor is used. This is to avoid voltage fluctuations and hot spots affecting the image quality. Further, the transistors are located as far away from the sensor as possible.

30 A standard JTAG (Joint Test Action Group) interface 228 is included in the ICP for testing purposes and for interrogation by the refill station. Due to the complexity of the chip, a variety of testing techniques are required, including BIST (Built In Self Test) and functional block

isolation. An overhead of 10% in chip area is assumed for chip testing circuitry for the random logic portions. The overhead for the large arrays, the image sensor and the DRAM[] is smaller.

5 The JTAG interface is also used for authentication of the refill station. This is included to ensure that the cameras are only refilled with quality paper and ink at a properly constructed refill station, thus preventing inferior quality refills from occurring. The camera must authenticate the refill station, rather than vice versa. The secure protocol is communicated to the refill station during the automated test
10 procedure. Contact is made to four gold plated spots on the ICP/[print head] printhead TAB by the refill station as the new ink is injected into the [print head] printhead.

Fig. 16 illustrates a rear view of the next step in the construction process whilst Fig. 17 illustrates a front camera view.

15 Turning now to Fig. 16, the assembly of the camera system proceeds via first assembling the ink supply mechanism 40. The flex PCB is interconnected with batteries 84 only one [84] of which is shown, which are inserted in the middle portion of a print roll 85 which is wrapped around a plastic former 86. An end cap 89 is provided at the other end of the print
20 roll 85 so as to fasten the print roll and batteries firmly to the ink supply mechanism.

The solenoid coil is interconnected (not shown) to interconnects 97, 98 (Fig. 8) which include leaf spring ends for interconnection with electrical contacts on the Flex PCB so as to provide for electrical control
25 of the solenoid.

Turning now to Figs. 17 - 19 the next step in the construction process is the insertion of the relevant gear [chains] trains into the side of the camera chassis. Fig. 17 illustrates a front [camera] view[,]. Fig. 18 illustrates a [back side] rear view and Fig. 19 also illustrates a [back
30 side] rear view. The first gear [chain] trains comprising gear wheels 22, 23 are utilised for driving the guillotine blade with the gear wheel 23 engaging the gear wheel 65 of Fig. 8. The second gear chain comprising gear wheels 24, 25 and 26 engage one end of the print roller 61 of Fig. 8. As best indicated in Fig. 18, the gear wheels mate with corresponding
35 [buttons] pins on the surface of the chassis with the gear wheel 26 being snap fitted into corresponding mating hole 27.

Next, as illustrated in Fig. 20, the assembled platten unit 60 is then inserted between the print roll 85 and aluminium cutting blade 43.

40 Turning now to Fig. 21, by way of illumination, there is illustrated the electrically interactive components of the camera system. As noted

previously, the components are based around a Flex PCB board and include a TAB film 58 which interconnects the printhead 102 with the image sensor and processing chip [51] 48. Power is supplied by two AA type batteries 83, 84 and a paper drive stepper motor 16 is provided in addition to a rotary guillotine motor [20] 17.

An optical element 31 is provided for snapping into a top portion of the chassis 12. The optical element 31 includes portions defining an optical view finder 32, 33 which are slotted into mating portions 35, 36 in view finder channel 37. Also provided in the optical element 31 is a lensing system 38 for magnification of the "prints left" number in addition to an optical pipe element 39 for piping light from the LED 5 for external display.

Turning next to Fig. 22, the assembled unit 90 is then inserted into a front outer case 91 which includes button 4 for activation of printouts.

Turning now to Fig. 23, next, the unit [92] 90 is provided with a snap-on back cover 93 which includes a slot 6 and copy print button 7. A wrapper label containing instructions and advertising (not shown) is then wrapped around the outer surface of the camera system and pinch clamped to the cover by means of clamp strip 96 which can comprise a flexible plastic or rubber strip.

Subsequently, the preferred embodiment is ready for use as a one time use camera system that provides for instant output images on demand.

It will be evident that the preferred embodiment further provides for a refillable camera system. A used camera can be collected and its outer plastic cases removed and recycled. A new paper roll and batteries can be added and the ink cartridge refilled. A series of automatic test routines can then be carried out to ensure that the printer is properly operational. Further, in order to ensure only authorised refills are conducted so as to enhance quality, routines in the on-chip program ROM can be executed such that the camera authenticates the refilling station using a secure protocol. Upon authentication, the camera can reset an internal paper count and an external case can be fitted on the camera system with a new outer label. Subsequent packing and shipping can then take place.

It will be further readily evident to those skilled in the art that the program ROM can be modified so as to allow for a variety of digital processing routines. In addition to the digitally enhanced photographs optimised for mainstream consumer preferences, various other models can readily be provided through mere re-programming of the program ROM. For example, a sepia classic old fashion style output can be provided through a remapping of the colour mapping function. A further alternative is to

provide for black and white outputs again through a suitable colour remapping algorithm. Minimum[less] colour can also be provided to add a touch of colour to black and white prints to produce the effect that was traditionally used to colourize black and white photos. Further, passport photo output can be provided through suitable address remappings within the address generators. Further, edge filters can be utilised as is known in the field of image processing to produce sketched art styles. Further, classic wedding borders and designs can be placed around an output image in addition to the provision of relevant clip arts. For example, a wedding style camera might be provided. Further, a panoramic mode can be provided so as to output the well known panoramic format of images. Further, a postcard style output can be provided through the printing of postcards including postage on the back of a print roll surface. Further, cliparts can be provided for special events such as Halloween, Christmas etc. Further, [kleidoscopic] kaleidoscopic effects can be provided through address remappings and wild colour effects can be provided through remapping of the colour lookup table. Many other forms of special event cameras can be provided for example, cameras dedicated to the Olympics, movie tie-ins, advertising and other special events.

The operational mode of the camera can be programmed so that upon the depressing of the take photo a first image is sampled by the sensor array to determine irrelevant parameters. Next a second image is again captured which is utilised for the output. The captured image is then manipulated in accordance with any special requirements before being initially output on the paper roll. The LED light is then activated for a predetermined time during which the DRAM is refreshed so as to retain the image. If the print copy button is depressed during this predetermined time interval, a further copy of the photo is output. After the predetermined time interval where no use of the camera has occurred, the onboard CPU shuts down all power to the camera system until such time as the take button is again activated. In this way, substantial power savings can be realized.

Ink Jet Technologies

The embodiments of the invention use an ink jet printer type device. Of course many different devices could be used. However presently popular ink jet printing technologies are unlikely to be suitable.

The most significant problem with thermal ink jet is power consumption. This is approximately 100 times that required for high speed, and stems from the energy-inefficient means of drop ejection. This involves the rapid boiling of water to produce a vapor bubble which expels the ink. Water has a very high heat capacity, and must be

superheated in thermal ink jet applications. This leads to an efficiency of around 0.02%, from electricity input to drop momentum (and increased surface area) out.

5 The most significant problem with piezoelectric ink jet is size and cost. Piezoelectric crystals have a very small deflection at reasonable drive voltages, and therefore require a large area for each nozzle. Also, each piezoelectric actuator must be connected to its drive circuit on a separate substrate. This is not a significant problem at the current limit of around 300 nozzles per [print head] printhead, but is a major
10 impediment to the fabrication of [pagewidth print heads] pagewidth printheads with 19,200 nozzles.

Ideally, the ink jet technologies used meet the stringent requirements of in-camera digital color printing and other high quality, high speed, low cost printing applications. To meet the requirements of
15 digital photography, new ink jet technologies have been created. The target features include:

- low power (less than 10 Watts)
- high resolution capability (1,600 dpi or more)
- photographic quality output
- 20 low manufacturing cost
- small size (pagewidth times minimum cross section)
- high speed (< 2 seconds per page).

All of these features can be met or exceeded by the ink jet systems described below with differing levels of difficulty. [45] Forty five
25 different ink jet technologies have been developed by the Assignee to give a wide range of choices for high volume manufacture. These technologies form part of separate applications assigned to the present Assignee as set out in the table [below] under the heading CROSS REFERENCES TO RELATED APPLICATIONS.

30 The ink jet designs shown here are suitable for a wide range of digital printing systems, from battery powered one-time use digital cameras, through to desktop and network printers, and through to commercial printing systems

For ease of manufacture using standard process equipment, the [print
35 head] printhead is designed to be a monolithic 0.5 micron CMOS chip with MEMS post processing. For color photographic applications, the [print head] printhead is 100 mm long, with a width which depends upon the ink jet type. The smallest print head designed is IJ38, which is 0.35 mm wide, giving a chip area of 35 square mm. The [print heads] printheads each contain 19,200
40 nozzles plus data and control circuitry.

Ink is supplied to the back of the [print head] printhead by injection molded plastic ink channels. The molding requires 50 micron features, which can be created using a lithographically micromachined insert in a standard injection molding tool. Ink flows through holes etched through the wafer to the nozzle chambers fabricated on the front surface of the wafer. The [print head] printhead is connected to the camera circuitry by tape automated bonding.

Tables of Drop-on-Demand Ink Jets

Eleven important characteristics of the fundamental operation of individual ink jet nozzles have been identified. These characteristics are largely orthogonal, and so can be elucidated as an eleven dimensional matrix. Most of the eleven axes of this matrix include entries developed by the present assignee.

The following tables form the axes of an eleven dimensional table of ink jet types.

- Actuator mechanism (18 types)
- Basic operation mode (7 types)
- Auxiliary mechanism (8 types)
- Actuator amplification or modification method (17 types)
- Actuator motion (19 types)
- Nozzle refill method (4 types)
- Method of restricting back-flow through inlet (10 types)
- Nozzle clearing method (9 types)
- Nozzle plate construction (9 types)
- Drop ejection direction (5 types)
- Ink type (7 types)

The complete eleven dimensional table represented by these axes contains 36.9 billion possible configurations of ink jet nozzle. While not all of the possible combinations result in a viable ink jet technology, many million configurations are viable. It is clearly impractical to elucidate all of the possible configurations. Instead, certain ink jet types have been investigated in detail. These are designated IJ01 to IJ45 above which match the docket numbers in the table under the heading Cross References to Related Applications.

Other ink jet configurations can readily be derived from these [45] forty-five examples by substituting alternative configurations along one or more of the 11 axes. Most of the IJ01 to IJ45 examples can be made into ink jet print heads with characteristics superior to any currently available ink jet technology.

Where there are prior art examples known to the inventor, one or more

of these examples are listed in the examples column of the tables below. The IJ01 to IJ45 series are also listed in the examples column. In some cases, a [printer] print technology may be listed more than once in a table, where it shares characteristics with more than one entry.

- 5 Suitable applications for the ink jet technologies include: Home printers, Office network printers, Short run digital printers, Commercial print systems, Fabric printers, Pocket printers, Internet WWW printers, Video printers, Medical imaging, Wide format printers, Notebook PC printers, Fax machines, Industrial printing systems, Photocopiers,
- 10 Photographic minilabs etc.

 The information associated with the aforementioned 11 dimensional matrix are set out in the following tables.

Orientation of the charts has been changed from landscape to portrait.

ACTUATOR MECHANISM (APPLIED ONLY TO SELECTED INK DROPS)				
	Description	Advantages	Disadvantages	Examples
Thermal bubble	<p>An electrothermal heater heats the ink to above boiling point, transferring significant heat to the aqueous ink. A bubble nucleates and quickly forms, expelling the ink.</p> <p>The efficiency of the process is low, with typically less than 0.05% of the electrical energy being transformed into kinetic energy of the drop.</p>	<ul style="list-style-type: none"> ◆ Large force generated ◆ Simple construction ◆ No moving parts ◆ Fast operation ◆ Small chip area required for actuator 	<ul style="list-style-type: none"> ◆ High power ◆ Ink carrier limited to water ◆ Low efficiency ◆ High temperatures required ◆ High mechanical stress ◆ Unusual materials required ◆ Large drive transistors ◆ Cavitation causes actuator failure ◆ Kogation reduces bubble formation ◆ Large print heads are difficult to fabricate 	<ul style="list-style-type: none"> ◆ Canon Bubblejet 1979 Endo et al GB patent 2,007,162 ◆ Xerox heater-in-pit 1990 Hawkins et al USP 4,899,181 ◆ Hewlett-Packard TIJ 1982 Vaught et al USP 4,490,728
Piezo-electric	<p>A piezoelectric crystal such as lead lanthanum zirconate (PZT) is electrically activated, and either expands, shears, or bends to apply pressure to the ink, ejecting drops.</p>	<ul style="list-style-type: none"> ◆ Low power consumption ◆ Many ink types can be used ◆ Fast operation ◆ High efficiency 	<ul style="list-style-type: none"> ◆ Very large area required for actuator ◆ Difficult to integrate with electronics ◆ High voltage drive transistors required ◆ Full pagewidth print heads impractical due to actuator size ◆ Requires electrical poling in high field strengths during manufacture 	<ul style="list-style-type: none"> ◆ Kyser et al USP 3,946,398 ◆ Zoltan USP 3,683,212 ◆ 1973 Stemme USP 3,747,120 ◆ Epson Stylus ◆ Tektronix ◆ IJ04



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We Claim:

1. In a portable camera system including:
an image sensor device for sensing an image;
a processing means for processing said sensed image; and
a printing system including a printhead for printing out said sensed image;
a method of color correcting a sensed image to be printed out by said [print head] printhead, comprising:
utilizing said image sensor device to sense a first image;
processing said first image to determine color characteristics of [a] said first [sensed] image;
utilizing said image sensor device to sense a second image, in rapid succession to said first image;
applying color correction [methods] to said second image based on the determined color characteristics of said first [sensed] image; and
printing out said second image.
2. A method as claimed in claim 1 wherein said second [sensed] image is sensed within 1 second of said first [sensed] image.

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MARKED-UP COPY**Abstract**

A camera [system is disclosed] include[ing:]es an image sensor [device] for sensing an image; a process[ing]or [means] for processing the sensed image; and a printing system for printing out the sensed image[;]. [a method of] The processor provides color correct[ing]ion of a sensed image [to] before being printed out by the [print head,]printhead comprising[:]the steps of utilizing the image sensor device to sense a first image; processing the first image to determine color characteristics of [a] the first [sensed] image; utilizing the image sensor device to sense a second image, in rapid succession to the first image; applying color correction [methods] to the second image based on the determined color characteristics of the first [sensed] image; and printing out the second image. Preferably, the second [sensed] image is sensed within 1 second of the first [sensed] image and the processing step includes examining the intensity characteristics of the first image. The processing step can also include determining a maximum and minimum intensity of the first image and utilizing the intensities to rescale the intensities of the second image.